Amendments to the Specification:

Please replace the paragraph on page 1 at lines 2-7 as follows:

The invention relates to a method of controlling a process of electrochemically machining an electrically conductive workpiece ~~as recited in the preamble of claim 1 as well as to a method of electrochemically machining as recited in the preamble of claim 30~~ in which electrolyte is supplied between the workpiece and an electrically conductive electrode, and an electric current is then applied between the workpiece and the electrode. Responsive to measuring a voltage induced by the electric current, a process control parameter is adapted. The invention further relates to an arrangement for ~~a performing a method of~~ controlling such a a process of electrochemically machining ~~as recited in the preamble of claim 39 as well as to an arrangement of electrochemically machining as recited in the preamble of claim 68~~.

Please replace the paragraph at page 1, line 26 through page 2, line 10 as follows:

However, in practice unwanted process conditions may arise that may degrade the normal machining operation. This may due for instance ~~due~~ to the generation of spark discharges that may occur within the gap. Such spark discharges may give rise to damages to the electrode and the workpiece. Another undesired process condition is the presence of gas-filled bubbles or cavities within the machining gap, causing non-conducting regions in the electrolyte. This may lead to an undesired ~~an~~ and undefined surface roughness of the workpiece. These gas-filled bubbles may rise owing to a temperature increase or pressure drop along the flow channel. If the growth is caused by temperature increase, due to for example the passage of current, boiling occurs. If the growth is due to pressure reduction, cavitation is said to have occurred. Another undesired process condition is called choking, which is induced ~~by~~ at a maximum in mass flow-rate as determined by the smallest area of the gap. A further undesired process condition is the occurrence of a passivating or a non-conductive layer on the workpiece surface.

Please replace the paragraphs at page 2, line 31 through page 3, line 27 as follows:

In consequence, amongst other things, it is an object of the invention to obviate above-mentioned disadvantages. In particular an object of the invention is obtaining a method of controlling a process of electrochemically machining, which allows ~~to monitor~~ monitoring one or more process conditions and ~~to adjust~~ adjusting the one or more process parameters in order to avoid undesired process conditions, especially while maintaining a constant gap width. According to one of its aspects a method according to the invention is characterized ~~as recited in the characterizing part of claim 1~~ by determining information relating to the spectral composition of the measured voltage within a predetermined measuring period during electrochemically machining, and responsive to that information, adapting the process parameter.

Varying process conditions give rise to a change of a measured voltage present for instance across a gap between the electrode and the workpiece. By choosing the measuring period such that a change can be detected within this measuring period, the change as a function of time or ~~shortly the~~ a form function defining the type of change within the measuring period can be distinguished. This form function can be decomposed ~~in to~~ into its constituent frequency components or frequency spectrum. By employing the information present in this frequency spectrum, indicators indicative of several process conditions, such as for example those mentioned above, can be obtained during the process of machining. It is found that the occurrence of a first process condition influences only a specific part of the spectrum, while a second process condition influences either ~~these~~ this part in another way or influences another part. As the information may be obtained continuously, the process may be continuously controlled in response thereto.

More specifically, it has found to be advantageous to employ the amplitudes of the frequency components of the frequency spectrum~~, according the method of claim 2~~ as the information.

A next advantageous method is to use a harmonic frequency of the waveform ~~according to the method of claim 3~~ of the measured voltage within the predetermined period. ~~Harmonic~~ As used in this specification and the appended claims, harmonic frequencies are hereby ~~being~~ defined as an integer multiple of the elementary frequency as determined by the length of the measuring period. Especially the lowest harmonic frequencies appear to be useful in defining process conditions.

Decomposing the form function according to a Fourier series, by a well known Fourier transformation~~, according to the method of claim 4~~ where the amplitudes correspond to the Fourier coefficients Ck of a series of trigonometric functions, has been found useful as a practical

mathematical embodiment. Although a form function may be decomposed in several elementary functions, each with a specific frequency, trigonometric functions such as sine and cosine appear to be most useful.

Please replace the paragraphs at page 3, line 33 through page 6, line 22 as follows:

A further advantageous method employs only the signs of the Fourier coefficients of a first number of harmonics, ~~according to the method of claim 5~~ and assigns a specific process condition to at lest one specific combination of these coefficients. Absolute values may vary ~~in~~ to a high degree, while signs, and especially the relative signs, are found to be a more stable indicator of process conditions.

It has been found that a first process condition of relatively low current density [[,]] may be assigned to the absence of a first consecutive number of Fourier coefficients Ck~~, according to the method of claim 6~~.

A next process condition, indicating the presence of gas-filled cavities in the electrolyte, is assigned to the presence of a second number of consecutive Fourier coefficients with alternating signs~~, according to the method of claim 7~~.

A further process condition, indicating a high current density, may be assigned to the presence of a third number of Fourier coefficients with mutually equal signs~~, according to the method of claim 8~~.

Another advantageous method is obtained by taking into account frequencies above a certain value, and monitoring only a change therein~~, according to the method of claim 9~~. This is found to be indicative of approaching a process condition susceptible of electric discharges in the gap. It has been found particular useful to monitor the running average of the corresponding amplitudes~~, according to the method of claim 10~~ across the predetermined time interval.

It has been found that several process control parameters may be adjusted, in response to the occurrence of changing process situations, to avoid undesired process conditions. In particular changing the duration of a current that is being applied, ~~according to the method of claim 11~~ from continuous to intermittent, has found to be useful. Applying the current intermittently [[,]] has the effect of reducing heating the electrolyte and therefore changing a process situation of boiling or cavitating.

A particular advantageous method is obtained when, during applying current intermittently, the electrode and the workpiece are moved relatively to each other in an oscillatory ~~harmonic~~ manner or in repeated non-harmonic manner superimposed on a linear movement, ~~according to the method of claim 12~~ while applying the current at or near the instant of smallest distance between the workpiece and the electrode. This allows increasing the electrolyte pressure in the gap when current is applied. This consequently counters the generation of bubbles in the electrolyte.

Applying a sequence of current pulses when a small distance between electrode and workpiece is present~~, according to the method of claim 13,~~ has the advantage of further countering the generation of bubbles.

An undesired process condition is characterized by the generation of a passivation layer on the workpiece, such as an oxide layer which forms a barrier between the workpiece and the electrolyte. An advantageous method is then obtained by applying current pulses of a normal polarity, and then at least one pulse of an opposite polarity ~~according to method of claim 14~~. This causes, as is known from document D2 in the list of referred references, the dissolving of the passivation layer.

A further undesired process situation may be characterized by a lack of machining accuracy. A useful process control parameter to improve a machining accuracy is the addition of passivation pulses ~~according to the method of claim 15~~ of the normal polarity but with a voltage whose amplitude is inadequate to dissolve the workpiece and a passivation film on the workpiece..

A next undesired process condition may arise due to a deposition of contaminating materials on the electrode. This leads to inaccurate machining as the distance between the electrode and workpiece may change in an undefined manner, either local or global. Especially in case of electrolyte which has been used for a long time, a deposition of dissolved metal ions of the dissolved workpiece may occur as a black layer along the total area of the electrode tool. This is called plating and may ~~effect~~ affect the geometrical dimensions. Another contamination is deposition of a hydroxide layer near the electrolyte outflow opening within the gap. This ~~does~~ not only ~~effect~~ affects the geometrical dimension but also the flow rate of the electrolyte. An advantageous process parameter is then the application of electrode cleaning pulses ~~according to the method of claim 16~~ with an opposite polarity.

~~A special next~~ In another embodiment ~~is obtained in a~~ of the method ~~where~~ the workpiece and the electrode are brought ~~in~~ into contact with each other prior to machining in order

to calibrate the mutual position. By applying the electrode cleaning pulses just before this action, ~~according to the method of claim 17~~ and applying a measurement current instead of a machining current to determine contact, an accurate calibration is obtained.

In a method wherein the electrode and the workpiece are moved relatively to each other in a repeated movement and the current pulses are applied when the distance between both is small, the machining accuracy may be high, due to the short distance allowable, but the productivity low, due to a slow flow of electrolyte. A useful process control parameter to adjust is the duration of the pulse periods~~, according to the method of claim 18~~. It has been found that decreasing the pulse period [[,]] may increase the amount of current which can be applied.

An advantageous value of the reduced pulse period is ~~obtained according to the method of claim 19~~ less that the seeding time for formation of gas bubbles in the electrolyte. The time needed for generation of nuclei preceding the formation of gas bubbles, such as for example hydrogen gas, is a practical criterion for determining the reduced pulse period. This is useful when higher current densities are being employed, normally leading to formation of gas-filled bubbles. With such extreme short pulses no time is left for formation of bubbles.

Although specific values may depend on specific circumstances, a first embodiment of the method employs ~~values according to the method of claim 20~~ pulse periods reduced to between 10 and 100 microseconds.

An important characteristic of such extreme short pulses is ~~the~~ a steep pulse forefront, which should have ~~values according to the method of claim 21~~ a value between 100 and 1000 nanoseconds.

In a process where sequences of intermittently applied electric current pulses are being applied, pauses between the pulses should preferably be ~~chosen according to the method of claim 22~~ in a sequence having a value larger than a time required for gas bubbles formed in the electrolyte to escape, with ~~specifically values according to the method of claim 23~~ preferably a ratio of pause to pulse duration between 2 and 10.

In a process wherein the electrode and the workpiece are moved relatively to each other in an oscillatory movement and the current is being supplied intermittently in pulse like periods when the distance between both is small, a further advantageous process control parameter is the relative phase shift between the movement and the start of applying the current~~, according to the method of claim 25~~.

In the same process ~~this also proves to be the case for~~ other advantageous process control parameters are the electrolyte pressure, ~~according to the method of claim 26,~~ and ~~for~~ the relative machining speed ~~according to the method of claim 27~~.

In a process wherein the current is applied in pulses, it is found advantageous to ~~take~~ make the pulse period substantially equal to the measuring period~~, according to the method of claim 28~~. In such a process, the process conditions are not stable within a pulse period, leading to a significant and informative change of the measure voltage during this pulse period.

In a process wherein the current is applied substantially continuously, an advantageous method is obtained by selectively choosing the measuring period~~, according to the method of claim 29~~ to be a fraction of the time that the current is applied continuously. Although generally such a process should have stable process conditions, and therefore no significant change in the measured voltage, deviations therefrom [[,]] may be detected~~. Such~~ such as those occurring at start-up, or at a disturbance during the process ~~and or~~ and/or at reaching an end of the machining.

Please delete the paragraph beginning at page 6, line 26, which starts with "A first advantageous".

Please delete the paragraphs beginning at page 7, line 1 through page 7, line 17, which start with "A further advantageous" and end with "desired process conditions."

Please replace the paragraph on page 7 at lines 18-20 as follows:

Further advantageous aspects of the invention ~~are relating~~ relate to an arrangement for electrochemically machining~~, are recited in the independent claims 39 and 68 respectively and in the dependent claims 40- 67 and 69 – 76 respectively~~ according to any of the above-described methods.

Please replace the paragraph on page 7 at lines 23-25 as follows:

These and further aspects and advantages of the invention will be apparent from and elucidated in more detail hereinafter with reference to the disclosure of preferred embodiments, and in particular with reference to the appended figures in which [[,]] :

Please replace the paragraph on page 8 at lines 23-25 as follows:

Fig. 14 to ~~Fig. 18 are showing~~ Fig. 18 show several methods according to the invention of controlling a process of electrochemically machining,

Please replace the paragraphs on page 8 at line 27 through page 9 at line 34 as follows:

Fig. 1 illustrates schematically an arrangement for electrochemically machining a workpiece 1. The workpiece 1 is carried by a table 2 which moves with a feed rate V1, by means of first positioning means 4, towards an electrode tool 3. The workpiece 1, the electrode tool 3 and the table 2 are electrically conductive. The electrode tool 3 may be moved relative to the workpiece 1 with an electrode feed rate V2 by means of second positioning means 5. The second positioning means 5 may cause the electrode tool 3 to perform an oscillatory movement such as a harmonic movement or a non-harmonic repeated movement relative to the workpiece 1. This may be realized by means of, for example, a crank shaft which is driven by a motor or by hydraulic means. The first positioning means 4 may comprise linear displacement means comprising a threaded shaft. The first positioning means 4 are controlled by a first positioning control signal S1 while the second positioning means 5 are controlled by a second positioning control signal S2. The workpiece 1 may be made of, for example, a hard metal such as titanium or an alloy [[,]] such as ~~chromium containing~~ chromium-containing steel. An electrolyte 18, for example an aqueous solution of nitrates of alkaline metals, flows in the gap 6 between the workpiece 1 and the electrode tool 3 and is circulated with an input pressure Pin and an output pressure Pout from a reservoir, not shown in the figure, by suitable circulating means 7 employing a pump. The electrode tool 3 and the table 2 are connected to a control circuit 8 comprising an electric power source that induces an electric current between the electrode tool 3 and the table 2 via the electrolyte 18. The induced electric current may be constant or pulsed. The normal polarity ~~being~~ is that the table 2, and consequently the workpiece 1, ~~is~~ are positive relative to the electrode tool 3. During current pulses of normal polarity the metal of the workpiece 1 dissolves in the electrolyte. A position of the table 2 is measured by position sensing means 9, which supplies a corresponding position signal Z to the control circuit 8. The part of the arrangement shown in Fig. 1 excluding the control circuit 8 will be denoted hereinafter to as the electrochemical process unit 10.

Fig 2 shows schematically an embodiment of the control circuit 8 of Fig. 1 in more detail. The control circuit 8 is separated ~~in~~ into a power supply unit 11, a control unit 12, monitoring means 13 and manual control means 14. The power supply unit 11 generates the required electric current I or voltage V, which is applied to the electrochemical process unit 10. The power supply unit 11 may ~~comprises~~ comprise several power supply sub units, not shown in the figure, to generate either a constant current or several types of pulsed current. It is noted that the power supply sub units do not need to be integrated in one unit but may be arranged in a system of cooperating independent sub units. The control unit 12 controls the operation of the power supply unit 11 with power supply control signals SEL1, SEL 2, CI1, CI2.... in accordance with the employed method of controlling and with received measurement signals Um, Z, P.... from the electrochemical process unit 10. The monitoring means 13 may comprise simple visual indicators, measurement devices or general display means. The manual control means 14 are used by an operator and may comprise simple switching means as well as a general keyboard. It is further noted that the control unit 12 may be constituted either in part or as a whole as dedicated hardware with a specific function or as a general-purpose computer loaded with a specific program.

Please replace the paragraph on page 11 at lines 15-33 as follows:

Curve I in Fig. 5 represents the variation of the size S(t) of the gap 6 between the workpiece 1 and the electrode tool 3 during an oscillatory movement relative to each other with a maximum size Smax and a minimum size Smin ~~and~~ while applying pulsed current Is according to curve II. Curve III shows the measured voltage Um across the gap 6. If no current Is is applied, no voltage Um is present. However, when a current Is of amplitude Is1 is applied, the measured voltage Um rises quickly. The distance S(t), in an initial stage, is comparatively large and the electrolyte flow may be turbulent and ~~containing~~ contain vapor and gas bubbles. Therefore the resistance across the gap 6 is relatively high, which is apparent from the first maximum Um2 of the measured voltage Um in curve II. As a result of the approach of the electrode tool 3, the pressure in the electrolyte 18 increases, causing the vapor and gas bubbles to dissolve so that the electrolyte 18 is homogenous and uniform in the gap and a high current density can be achieved with a small gap size. As a consequence, the electrical resistance decreases, which is apparent for the occurrence of a local minimum of the voltage Um in curve ~~II~~ III. As a result of the increasing distance S(t) and a

renewed formation of vapor and gas bubbles, the electrical resistance increases again leading to a second maximum ~~Um2~~ Um3 of the voltage Um. The application of electric power may be so large that the electrolyte begins to boil violently, giving rise to extra bubble formation in the gap 6. This causes a temporary increase of the electrical resistance of the electrolyte 18, which manifests itself as a local maximum Um1 of the voltage Um.

Please replace the paragraph on page 12 at lines 21-34 as follows:

As already illustrated with reference to the Figures 4 - 6, the measured voltage Um across the gap, caused by the current flowing through the gap, shows significant variations in the relation of amplitude Um versus time t. Fig. 7 shows some characteristic examples of measured voltages Um during a predetermined measuring period Tm induced by applying current to an electrochemical cell. Curve I illustrates an example as may occur during applying current pulses in combination with an oscillatory movement such as illustrated with reference to Fig. 5. It is noted that only the voltage Um within a measuring period Tm smaller ~~then~~ than a pulse period is shown, ~~leaving away~~ while the less informative parts of the measured voltage are omitted. Typically one local minimum is present at approximately at the instant of smallest size S(t) of the gap 6. At the end the voltage Um increases due to increasing size S(t). Curve II illustrates an example with different process conditions, characterized by the occurrence of a local maximum due to a non-uniform electrolyte caused by generation of bubbles due to a high current density. Curve III gives an example illustrating even worsening process conditions, characterized by the occurrence of several local maxima.

Please replace the paragraphs on page 13 at lines 9-21 as follows:

Curves VII, VIII, IX ~~illustrates~~ illustrate examples of different slopes of the forefront of measured voltage Um, when applying current pulses with extremely short duration. For example, a favorable process condition may be obtained with a steep increase of the measured voltage Um, as in that case less time is left for generation of bubbles in the electrolyte 18.

Curves X, XI and XII illustrate typical examples of the measured voltage Um as may occur when applying a substantially constant current, as explained with reference to Fig. 4. The

measuring period Tm is chosen such that significant changes in process conditions may be detected in time~~. For~~ , for example with curve XI illustrating stable process conditions and with curve XII illustrating changing process conditions, due ~~to~~ for instance to changing composition of the electrolyte 18 or changing flow of electrolyte. Curve X illustrates a process condition with increased noise of the measured voltage Um. This may be indicative of near short circuit conditions, caused by local discharges.

Please replace the paragraphs on page 13 at line 28 through page 14 at line 24 as follows:

Fig. 8 shows a first embodiment of such a method according to the invention for determining a characteristic waveform of a measured voltage Um such as shown in Fig. 7. The respective steps will be explained with reference to Fig. 9, showing the immediate results of quantifying. The method will be explained with reference to a measured voltage Um as a function of time t as shown as curve I in Fig. 9. This curve I may be induced by a current pulse applied during an oscillating movement of electrode tool 3 and workpiece 1 relative to each other, according to a process of electrochemically machining as illustrated with reference to Fig. 5. The measuring period Tm is chosen equal to the pulse period~~, which information~~ . Information regarding the current pulse timing and duration may be obtained from the power supply unit 11. It is remarked that although the depicted curves seem to be continuous, in practice sampled and digitized points of the curves will be used. Preferably a table of sampled values Ui (Ti) versus time instants Ti is used to characterize the measured voltage Um as a function of time t. This is performed with a sampling step 31.

Subsequently, ~~excluded from this table are~~ samples during initial and final parts of the measured sampled voltage Us (t) that ~~are occurring~~ occur during a ~~transitive~~ transitional or transient process in the power supply unit 11 are excluded from this table. This is done in a cutting step 32 where an initial part Ta and a terminal part Te, ~~connected to~~ resulting from a transient process, are ~~being~~ excluded from the measuring period Tm to obtain a corrected measuring period ~~Tm'~~ T'm. Information with respect to the size of these parts Te and Ta may be obtained either from the power supply unit 11 or may be obtained by analyzing the measured samples. Alternatively, the size of Te and Ta may be determined in advance. Further, the measuring period Tm may be chosen in advance ~~such~~ so as to exclude transient parts from the beginning. The resulting sampled ~~form~~ waveform Us (t) after cutting is shown as curve II in Fig. 9.

Next, in a linearization step 33, a linear function Ulin(t) is derived from the samples Us determined so far. The linear function Ulin(t) is characterized by the values Ua and Ue of the measured sampled voltage Ui at the beginning and at the end respectively of samples Us resulting after cutting and is given by :

$$\text{Ulin}(t) = \text{Ua} + ((\text{Ue} - \text{Ua}) / T^*) \,.\, t \qquad [1]$$

with T* = ~~Tm'~~ T'm. Curve III in Fig. 9 shows an example of such a linear function Ulin(t).

Please replace the paragraph on page 15 at line 15 through page 16 at line 5 as follows:

The following step is ~~a~~ an oscillating function building step 37, where a ~~sinus~~ sinusoidal function is ~~build~~ built that corresponds to the oscillating movement of the electrode tool 3 and workpiece 1 relative to each other, according to a process described with reference to Fig. 5 with curve I. The distance S(t) of the gap 6 is represented by the following function :

$$S(t) = \sin [\omega(t - T^*/2) + \pi/2] \qquad [3]$$

with ω the oscillating frequency in rad/s. Curve VI illustrates this function S(t). Analogous to the previous linearizing step 33, a linear function Slin(t) is ~~build~~ built based on the sizes Sa and Se of the function S(t) at the start and the end of the corrected measuring period, as shown schematically with curve VI in Fig. 9 :

$$\text{Slin}(t) = \text{Sa} + (\text{Se}-\text{Sa})/T^* \,.\, T \qquad [4]$$

Also analogously, this linear function Slin (t) is subtracted from the function S (t) to obtain a differential function Sd (t) :

$$\text{Sd}(t) = \text{St}(t) - \text{Slin}(t) \qquad [5]$$

Next, still in the oscillating function building step 37, a smooth continuous function S* (t) is formed by conjugation of the differential function Sd (t). This is done by symmetrically reflecting the differential function Sd (t) relative to the horizontal and vertical axis, as shown as curve VII in Fig. 9. The resulting smooth function S* (t) is a periodically odd function, that has a continuous first derivative.

Please replace the paragraphs on page 17 at lines 3-16 as follows:

It is also noted that subtracting a linear function is not essential to the method of the invention, but is to be regarded as an advantageous embodiment. The same ~~accounts to~~ is true for subtracting the coefficients corresponding to an oscillatory movement. Herewith it should be realized that the above given example of expansion has been illustrated with reference to a specific process, involving pulsed current with an oscillatory movement of electrode tool 3 ~~on~~ with respect to workpiece 1. In case of no relative movement during a measuring period, such subtraction may be less advantageous. On the other hand, different kinds of movements may be present and ~~which~~ need to be corrected for.

The above described may be performed employing ~~with~~ dedicated hardware, a general purpose computer programmed with suitable software or a combination of both. Further to increase speed, as typically every 20 ms a decision may be necessary, tables with sine and cosine values may be employed. The number of harmonics may be limited approximately to 10, as low frequency distortions can be described by 10 harmonics with a precision of about 1%.

Please replace the paragraphs on page 17 at line 24 through page 18 at line 2 as follows:

A type 1 process condition is assigned to the absence of the harmonics 2 –10, indicated with the value '0'. Type 1 process conditions are ~~being~~ characterized by ~~appearing~~ the appearance of a dark-gray or black film on the machining surface, high roughness and a low productivity caused by a low current density.

A type 2 process condition is assigned to the presence of the harmonic numbered 2 and 4 with a negative amplitude '-1' and of the harmonic numbered 3 with a positive amplitude '+1'. Type 2 process conditions are being characterized by the appearing of a dense dark ~~file~~ film

on the machining surface, high roughness, low productivity caused by boiling up of the electrolyte or reaching a limit value of gas-filling of the electrolyte.

A type 3 process condition is assigned to the presence of the harmonics numbered 2,3,4,5 and 6 with a negative amplitude. Type 3 process conditions are ~~being~~ characterized by the ~~appearing~~ appearance of a regular wavy surface along the electrolyte flow, a low precision of copying and a high power consumption.

Please replace the paragraphs on page 18 at line 24 through page 19 at line 23 as follows:

Fig. 20 shows the Fourier coefficients Ck primarily as a function of the process control parameter for the electrolyte pressure Pin for the same process with constant minimal applied voltage Umin=10,0 V and approximate constant gap size S. Curve I depicts the situation with Pin=400 kPa and S=30 μm, curve II with Pin=100 kPa and S=46μm and curve III with Pin=30 kPa and S=36 μm. Reducing the pressure Pin results in the generation of a local maximum in the waveform constituted by Um. This is reflected by ~~Fouriercoefficients~~ Fourier coefficients of alternating sign, leading to a type 3 process condition as shown by bar 78 of curve III.

Fig. 21 shows the Fourier coefficients Ck as a function ~~from~~ of the gap size S of the same process. The electrolyte pressure Pin is kept at 400 kPa while the minimum applied voltage Umin is kept to 10,0 V. Curve I depicts the situation with S=26 μm, curve II with S=36μm and curve III with S= 46 μm. It can be seen that with an increasing size S, gradually a type 3 process condition is being obtained.

~~Fig.12~~ Fig. 12 shows a further embodiment of the method according to the invention for deriving spectral information. Curve ~~1of~~ 1 of Fig. 12 shows an example of measured voltage Um in case of applying a current pulse. In this embodiment the high frequency information content is analyzed ~~in stead~~ instead of the low frequency content as defined by a number of up to 10 harmonics as described before. The high frequency content comprises harmonics substantially higher then 10. The indicated area 40 indicates typical high frequency variations. Curve II in Fig. 12 shows the measured voltage UmHF after amplification and high pass frequency filtering the voltage Um. The measuring period Tm should be chosen such that the large spikes 41 and 42 present at the beginning and at the end of the measured pulse, should be excluded. These spikes are mainly due to switching actions in the power supply circuit and are not characteristic of process

conditions. The depicted curves I and II may be indicative of normal process conditions. However, curve III in Fig. 12 corresponds to a changed process condition, as indicated by the distortion 43. Curve IV shows again the amplified and high pass frequency filtered measured voltage UmHF. Two parts can be distinguished in this curve IV: a part 44 with relatively low amplitudes and a part 45 with relatively high amplitudes. The part 44 ~~being~~ is indicative of a so-called ~~before accident~~ before-accident ECM regime. ~~With an~~ The term accident ECM regime ~~is meant a~~ means process conditions with the occurrence of electrical discharges. The occurrence of such a process condition should be avoided as the electrode tool or workpiece may be damaged. The change in amplitude of the high frequency content as indicated with UmHF appears to be a good indicator of such a before accident ECM regime.

Please replace the paragraph on page 20 at lines 1-11 as follows:

After having obtained the amplified and high pass frequency filter voltage UmHF as shown in curve IV of Fig. 12, a further advantageous method is obtained by taking the absolute value thereof : AUmHF. It is noted that the valued of Um or UmHF may be sampled and digitized, so all steps may be performed digitally. For example a number of sampling points may be chosen equal to 2000 during a measuring period Tm. Next a running average IAUmHF of AUmHF may be obtained with respect to a specific interval, for instance of 300 points. Curve V in Fig. 12 illustrates two possibilities that may result: one curve 47 corresponding to a normal ECM process condition such as indicated with curve II and one curve 46 corresponding to a ~~before accident~~ before-accident ECM process condition corresponding with curve IV. The occurrence of a difference between a reference value of IAUmHF and an actual value [[,]] may be chosen as an indicator.

Please replace the paragraphs on page 21 at lines 3-23 as follows:

These form functions are expanded in a Fourier series with the Fourier expansion unit 53 in a manner as explained with reference to Fig. 8 and Fig. 9. The Fourier expansion unit 53 supplies corresponding Fourier coefficient signals Ck to monitoring means 13 for display and to assignment means 54. Assignment means 54 ~~are assigning~~ assign typical process conditions to characteristic series of Fourier coefficients Ck in a manner as explained with reference to table 1. A

resulting signal T represents the type of process condition that is being outputted to monitoring means 13 and to the regulating unit 49.

The sampled signals generated by the sampling unit 50 are also supplied to a high frequency determining part comprising a high pass filter 55, an amplifier 56, an absolute value unit 57, an averaging unit 58 and a difference unit 59. The sampled signals supplied to the high pass filter 55 may be analog or digital. As mentioned before, the high pass filter 55 should pass variations in the measured voltage Um with frequencies from, for example, 20 kHz. The subsequent amplifier 56 is used to amplify the relative variations in voltage Um. At this stage it is remarked that ~~in stead~~ instead of using the amplified and filtered signals so far, the Fourier coefficients Ck such as generated by the Fourier expansion unit 53, provided that this unit is adapted to determine amplitudes of higher numbered harmonics.

The absolute value unit ~~58~~ 57 takes the absolute value of the signal inputted while the averaging unit 58 determines a running average, both in accordance with the method disclosed with reference to Fig. 12. Finally, a difference unit 59 determines the difference between a result obtained with normal process conditions. A signal Ac representing the presence of a pre-accident process situation is supplied to the regulating unit 49.

Please replace the paragraphs on page 23 at lines 13-30 as follows:

Fig. 15 illustrates a second method of controlling employing as a first process control parameter the supply of current Is continuously or intermittently and as a second process control parameter either a constant size S(t) or an oscillating size S(t) of the gap between electrode tool 3 and workpiece 1. Curve I of Fig. 15 illustrates a first operational phase 63 with a constant supply of current Is at an initial size Sint and a second operational phase 64 with a pulsed supply of current Is during an oscillating movement. During the measuring periods Tm1, at part 65 of the curve III, an increase in measured voltage Um is measured by the evaluating unit 48, indicating for instance an increase of electrical resistance, caused by the formation of gas bubbles in the electrolyte 18. The regulation unit 49 causes the power supply unit 11 to apply only current during instants of smallest size Smin of an oscillatory movement~~. Thus~~ , thus avoiding formation of gas bubbles due to an increased electrolyte pressure in the gap 6 during the instants of smallest size. During the instants of largest sizes Smax of the oscillatory movement, no current is supplied and the liquid can be replenished. Changing from the first operational phase 63 to the second

operational phase 64 enables maintaining stable process conditions. The voltage Um is still measured during the pulses during measuring periods Tm2, in order to determine the limit of process control parameters such as the phase φ between the moment of smallest distance and the moment of application of the pulse.

Please replace the paragraphs on page 25 at line 1 through page 27 at line 22 as follows:

It is noted that a high local pressure also results in avoiding formation of gas bubbles. Although the electrolyte input pressure Pin may be 2 bar, a local pressure may increase to 50 bar. In that case boiling will only occur at ~~must~~ much higher temperatures.

Further the physical effect obtained under these extreme short pulses may be similar to a local melting of the work piece~~. The~~ , the local melt being formed in small ionized channels ~~where after~~ whereafter the ~~molted~~ molten material is immediately dispersed through the electrolyte.

Next a fourth method is illustrated with reference to Fig. 17. Curve I shows the variation of the size S(t)versus the time t. Before establishing the machining distance Smin, the electrode tool 3 contacts or taps the workpiece 1. Curve II in Fig. 17 illustrates that a sequence of machining current pulses with a normal polarity is being applied. As indicated by curve III in Fig. 17, the variation 73 of measured voltage Um induced by a current pulse may indicate, by evaluation of the Fourier coefficients, the formation of a sedimentation layer on the electrode tool 3. The electrode tool 3 itself may be made of metals like copper, chromium or chromium-nickel and the like. However metals like titanium will not lead to the formation of an oxide layer. This is also not likely to happen as during machining the electrode tool 3 is being kept at a negative voltage relative to the workpiece 1. However, what might happen is the attraction of positively charged particles such as remnants of acids, present in the electrolyte and the formation of a layer thereof on the electrode tool ~~3. These~~ 3. These particles are not strongly attached to the electrode tool by ~~due to~~ a chemical reaction and therefore may be removed therefrom by applying ~~temporally~~ temporarily a positive voltage to the electrode tool 3. This is realized by inducing a current pulse 74 of a negative polarity such as illustrated in curve II. It is noted, that alternatively the same result may be obtained by applying a voltage pulse of inverted polarity. Applying such pulses causes the loosely attached sediments to go ~~in~~ into solution again. In addition, the remnants of metals in the electrolyte such as chromium and nickel, which may be deposited on the electrode, known as the plating effect, may

be removed by the above mentioned cleaning pulses. Applying cleaning pulses may be induced by changed geometrical values but also a reduced amount of flow of electrolyte.

Fig. 22 illustrates a next advantageous method of combining two kinds of voltage pulses of inverted polarity with a current pulse of normal polarity. Curve I depicts the generation of a sequence of current pulses of normal polarity with amplitude Ig1 induced by control signal CI2 as described with reference to Fig. 3. Curve II depicts the generation of a sequence of voltage pulses of opposite polarity with a first amplitude Uc and a second amplitude Un induced by control signal CU2 as described with reference to ~~Fig.3~~ Fig. 3. The voltage pulses with amplitude Un ~~serving~~ serve to dissolve a passivating layer formed on the workpiece 1, in accordance with the method disclosed in more detail in document D2 in the list of referred documents which can be found at the end of the description. A passivation layer is formed by a dark oxide film. The required ~~voltage~~ depassivation voltage Un should preferably lie between the polarization voltage Upol, which is explained with reference to curve IV, and the voltage Unmax at which the electrode begins to dissolve. This is explained in detail in document D2. The voltage pulses with amplitude Uc serve to clean the electrode tool 3 in a manner as disclosed with reference to Fig. 17. The value Uc is preferably larger than the value Un, the last one chosen such as not to dissolve the electrode tool 3. The disadvantage of the higher value of Uc ~~being thus~~ is dissolution of the electrode tool 3. This may be prevented by employing non dissolving electrode materials such as platinum or by employing a passivating electrolyte such as sodium nitrate in combination with a chromium-steel electrode. With this last choice of electrolyte and electrode material, the value Uc should not be larger then 3,6 V as otherwise the passivating functioning is stopped and the electrode will start to dissolve. Preferably the value is kept below 2 V. How many and with which length the cleaning pulses have to be applied, will have to be determined by trial and error. For instance, after every 20 s machining ~~applying~~ one cleaning pulse of 1 s may be applied.

Curve III shows the combined current Ig passing the gap 6 as a result of the applied current and voltage pulses. The current pulse of normal polarity has an amplitude Ig1, the voltage pulses of opposite polarity induce a maximum current of Ig2 and Ig3. Curve IV shows the measured voltage Um across the gap ~~6. The~~ 6, the voltage pulses of opposite polarity having amplitudes of Um1 and Um2. The voltage Um measured immediately after termination of the current pulse, while no other pulses are being applied, is called the polarization voltage Upol, which eventually ~~decreasing~~ decreases to zero.

Thus an advantageous method is obtained by choosing as a process control parameter the application of such an electrode tool cleaning pulse, if the evaluation of the process condition, such as apparent from the spectral content of the measured voltage Um, indicates pollution of the electrode tool. Especially in case of electrolyte which has been used for a long time, a deposition of dissolved metal ions of the dissolved workpiece may occur as a black layer along the total area of the electrode tool. This is called plating and may effect the geometrical dimensions. Another contamination is deposition of a hydroxide layer near the electrolyte outflow opening within the gap. This ~~does~~ not only ~~effect~~ affects the geometrical dimension but also the flow rate of the electrolyte. It is noted that such an electrode tool cleaning pulse may also be applied in advance, at predetermined instants.

Fig. 18 illustrates a next advantageous embodiment, based on an oscillatory movement as indicated by curve I in Fig. 18. Machining current pulses 76 are ~~being~~ applied as indicated by curve III. An advantageous process control parameter is obtained by applying so-called passivation pulses 77 of the same polarity but with smaller amplitude. These pulses are ~~being~~ applied when the ~~gape~~ gap size is large, so as to avoid undesired distortions of the shape. As disclosed in more detail in document D3, in the list of referred documents that can be found at the end of this description, such passivation pulses improve the machining copying accuracy as a passivation layer is formed on those ~~surface~~ surfaces of the ~~workpiece1~~ workpiece 1 which ~~is~~ are not ~~or less~~ to be machined, or from which less material is to be removed. Evaluation of the process conditions by the spectral content may induce a change from a relatively low precision machining process to a relatively high precision machining process and vice versa. This may also be induced after having machined a predetermined amount of material out of a total amount to be machined, for instance 80 μm out of a total of 120 μm.

It is remarked, that although the several current and voltage sources are shown to be incorporated in one unit, in practice the sources may be placed apart and connected by suitable connection means to the electrochemical process unit 10 and the control unit 12. Further, one or more sources may be ~~missing~~ omitted or one ore more sources may be added, ~~in dependence of~~ depending on the method according to the invention.

Further it is remarked ~~to~~ that a transition from one type of process of electrochemically machining to another type [[,]] may be performed either automatically or manually. Manually changing may imply the changing of the electrochemical process unit 10, of the power supply unit 11 or of a current or voltage source.